Specification

1. Title of the Invention

Diaphragm for Speaker

2. Claims

(1) A diaphragm for a speaker having a three-layer sandwich structure wherein surface materials made of a thin film of a fiber reinforced plastic are pasted to two surfaces of a center material made of a core material, characterized in that a woven cloth made of carbon fibers plated with a metal is used as a base of at least one surface material.

(2) The diaphragm for a speaker according to Claim 1, characterized in that the core material has a honeycomb core made of a thin film of a metal or a polymer material.

(3) The diaphragm for a speaker according to Claim 1 or 2, characterized in that the metal plating is of one or more type(s) of metal(s) selected from among nickel, zinc, copper and tin.

3. Detailed Description of the Invention

[Field of Industrial Application]

This invention relates to a diaphragm for a speaker having a sandwich structure with excellent frequency properties in a high-pitched tone range.

[Prior Art]

In general, diaphragms for speakers are required to have such properties that: (a) the surface density is small; (b) the specific modulus E/ρ is great (E: elastic modulus, ρ: density); (c) an appropriate internal loss ($\tan\delta$) is provided; and (d) the bending rigidity is great. In particular, cone-shaped diaphragms are required to have a large specific modulus because vibrations in the voice coil bobbin must be propagated with high fidelity to the inner peripheral portion (voice coil side). Meanwhile, it is idealistic for the internal loss to have an appropriate magnitude because the outer peripheral portion (edge side) must absorb vibrations reflected from the edge.

Some diaphragms for speakers according to the prior art have a three-layer sandwich structure wherein surface materials made of a thin film of a fiber reinforced plastic are pasted to two surfaces of a center material made of a core material having a honeycomb core or the like made of a thin film of a metal or a polymer material. In addition, as the base of the above-described surface materials, woven cloths made of carbon fibers, glass fibers, aromatic polyamide fibers and the like have been proposed for use (for example, Japanese Unexamined Utility Model Publication S56 (1981)-43994).

[Problem to be Solved by the Invention]

The bases of the conventional diaphragms for speakers which have a three-layer sandwich structure with carbon fibers or glass fibers as the base have a large elastic modulus, and therefore, the specific modulus of the sandwich structure is great, making the structure effective as a diaphragm. However, the specific modulus and the internal loss are, in general, in an inversely proportional relationship, and therefore, the internal loss becomes small, thereby making the properties required for the diaphragm for a speaker fail to be sufficiently satisfied. In addition, though diaphragms for speakers with aromatic polyamide fibers as the base have a large internal loss and a great specific modulus in comparison with those with carbon fibers or glass fibers as the base, there is a problem that their properties do not reach the idealistic level of properties.

The present invention is provided in order to solve the above-described problem, and an object thereof is to provide a diaphragm for a speaker having a large specific modulus and an appropriate internal loss which satisfies the properties required for the diaphragm for a speaker.

[Means for Solving the Problem]

The diaphragm for a speaker according to this invention is a diaphragm for a speaker having a three-layer sandwich structure wherein surface materials made of a thin film of a fiber reinforced plastic are pasted to two surfaces of a center material made of a core material, wherein a woven cloth made of carbon fibers plated with a metal is used as a base of at least one surface material.

Core materials, such as a honeycomb core made of a thin film of a metal or a polymer material, can be used as the core material to be the center material, which may have a structure wherein bending properties are increased with portions thereof being omitted. A woven cloth used as the base of either one or both of the surface materials which is/are pasted to the two surfaces of this core material is formed of carbon fibers plated with a metal. Though there are many metals for plating, nickel, zinc, copper, tin or the like is preferable, and one or several type(s) is/are plated on the carbon fibers. It is preferable for the thickness of the plating layer to be 0.05 μm to 0.5 μm. Single or roving fibers of the carbon fibers are plated in such a state that the intervals between the single fibers are maintained, and it is preferable for the plating layers to be uniformly formed throughout the entirety of the surface of the respective single fibers.

It is preferable for a woven cloth, such as of plain fabrics, to be formed of roving carbon fibers plated with a metal as described above, and for this to be used as the base of a surface material, and the woven cloth may be formed of yarns. When such a woven

cloth is used as the base of one surface material, a conventional woven cloth made of carbon fibers or glass fibers is used as the base of the other surface material. These bases are impregnated with a resin, such as an epoxy resin, and the resin is cured through the application of heat and pressure so that a fiber reinforced plastic is gained, and thus, surface materials are formed. Then, these surface materials are layered on and then pasted to either surface of the above-described core material so that a sandwich structure is gained, and thue, a diaphragm for a speaker is gained.

[Working Effects]

The thue gained diaphragm for a speaker is attached to a speaker frame, connected to a voice coil, and used in the same manner as conventional ones. At this time, the diaphragm for a speaker has a high specific modulus, and therefore, vibrations from the voice coil bobbin are conveyed with high fidelity, and the internal loss has an appropriate magnitude so that vibrations reflected from the edge are absorbed and the frequency properties in a high-pitched tone range have a small disturbance.

[Embodiment]

In the following, one embodiment of this invention is described in reference to the drawings. Fig. 1 is a cross sectional diagram showing the embodiment, Fig. 2 is a plan diagram showing a base, and Fig. 3 is a cross sectional diagram showing the base along A-A of Fig. 2. In the drawings, (1) indicates a diaphragm for a speaker, which is formed in cone form where surface materials (3) and (4) are pasted to the inside and outside of a core material (2) having a honeycomb core of an aluminum foil, and thus, a three-layer sandwich structure is established. The surface materials (3) and (4) are gained by using a woven cloth (6), which is made of plain fabrics of rovings (5) as a collective body of single threads wherein carbon fibers are plated with a metal, as the base and impregnating this with a resin, which is then cured through the application of heat and pressure so as to be converted to a fiber reinforced plastic.

The base of the rovings which are carbon fibers having a diameter of 7 μm was plated with nickel having a thickness of 0.1 μm, and furthermore, the rovings were plated with zinc having a thickness of 0.1 μm, and then, woven to a cloth of plain fabrics. This was impregnated with an epoxy resin and cured through the application of heat while being pressed so that the surface material (3) or (4) having a volume content of the fibers of approximately 50% and a thickness of 0.12 mm was gained. An aluminum honeycomb core having a cell size of 3/16 inches and a thickness of 3 mm made of an aluminum foil having a thickness of 0.05 mm was used as the core material (2). In addition, the above-described surface materials (3) and (4) are pasted to either side of the core material (2) with an adhesive made of an epoxy resin, and then, heat and

pressure were applied for adhesion, and thus, a diaphragm for a speaker having a three-layer sandwich structure was gained. The values of the specific modulus E/ρ and the internal loss tan δ, which were found for the gained sample pieces in accordance with a vibration reed method, are shown in Table 1.

As comparative examples, the results from three-layer sandwich plates having woven cloths made of rovings of carbon fibers and glass fibers as the base and a conventional paper cone are also shown in Table 1.

Table 1

	Material for base	Specific modulus E/ρ (cm^2/sec)	Internal loss tan δ
Embodiment	Carbon fibers plated with metal	9.8×10^{10}	0.065
Comparative examples	Carbon fibers	4.0×10^{11}	0.02
	Glass fibers	1.8×10^{11}	0.03
	Paper cone	3×10^{10}	0.05

As is clear from Table 1, when a surface material made of carbon fibers plated with a metal according to the present invention is used, the specific modulus becomes approximately the same as that of the glass fibers according to the prior art and the internal loss becomes approximately the same as that of the paper cone according to the prior art, while the range of the piston motion can be expanded to approximately two times greater than that of the diaphragm of the paper cone according to the prior art. In addition, disturbance in the frequency properties in the high-pitched tone range is small due to great internal loss in such a manner that the intrinsic noise specific to honeycomb diaphragms is silenced, and thus, it can be seen that a diaphragm for a speaker having a three-layer sandwich structure, which is extremely effective in terms of physical properties and auditory properties, can be gained.

[Effects of the Invention]

As described above, according to the present invention, a woven cloth made of carbon roving fibers plated with a metal is used as the base, and therefore, a diaphragm for a speaker having a great specific modulus, an appropriate internal loss and excellent frequency properties in a high-pitched tone range can be gained.

4. Brief Description of the Drawings

Fig. 1 is a cross sectional diagram showing an embodiment; Fig. 2 is a plan diagram showing a base; and Fig. 3 is a cross sectional diagram showing the base along

A-A of Fig. 2.

In the drawings, the same symbols indicate the same or corresponding portions, where (1) indicates a diaphragm for a speaker, (2) indicates a core material, (3) and (4) indicate surface materials, (5) indicates rovings and (6) indicates a woven cloth.

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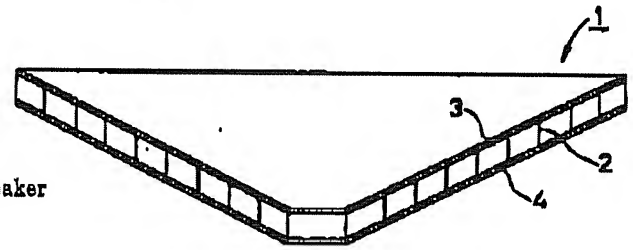
Fig. 1



1: diaphragm for speaker

2: core material

3, 4: surface materials

5: rovings

6: woven cloth

Fig. 2

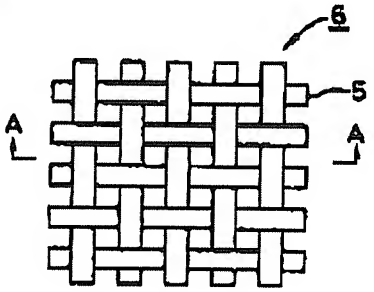


Fig. 3